THE SUPPLY OF INFORMATION IN AN EMOTIONAL SETTING

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Abstract

Advances in the field of economics and psychology have contributed greatly to the understanding of the supply of information when it affects the emotions and consequently the decisions made by two parties. Yet, these studies assume the parties have identical utilities. In this paper, focusing on the doctor-patient interaction, we relax the perfect agency assumption, introduce the agent's effort in supplying information, and analyse the two parties' interdependent decisions under asymmetric information. We show that when the supplier of information fails to understand the receiver's preferences the latter will disregard completely the recommendation. We consider the policy recommendations and welfare implications of the model.

Key words: supply of information, Psychological Expected Utility, non-cooperative game theory, doctor-patient relationship, policy recommendations, welfare implications.

JEL Classification: C72, D8, I1

I. INTRODUCTION

Recent advances in the literature of economics and psychology have contributed greatly to explaining the supply of information when this affects the emotions of the agents and consequently their decisions. The models draw upon the Psychological Expected Utility (PEU) theory introduced by Caplin and Leahy (2001). The PEU is an extension of von Neumann-Morgenstern expected utility theory to situations in which agents experience feelings of anticipation regarding future states.

The PEU has been used by Caplin and Leahy to explain the optimal level of information an expert should pass on to an ill-informed citizen (Caplin and Leahy 2004). Köszegi (2004) has also proposed a model describing the doctor-patient relationship based on the PEU theory identifying a number of complications in their interaction that are attributed to anxiety, such as the paradox of emotional patients getting less useful information. In another paper, Köszegi (2003) develops a model focusing on the patient’s decision whether to visit a doctor or not, when anxiety enters his utility function. He then further develops it in a more general case of the emotional agent (Köszegi 2006).

However, all the above attempts to model the supply of information when emotions are affected are based on the assumption that the provider of this information is entirely empathetic to the other party and maximizes his utility function as if it were her own. In other words, all models assume perfect agency relationship. But what happens if the supplier of the information does not know the preferences of the other person? What if, in addition, the transmission of information is costly?

The objective we are pursuing in this paper is precisely to answer the above questions. Our aim is to develop a model of the supply of information between two agents, when this information affects their emotions but it is also costly for the provider of the information to pass it on to the other party. Furthermore, asymmetry of information adds more complications in reaching a mutually agreed decision. For that purpose we employ a non-cooperative game theoretical model focusing on the doctor-patient relationship as an emotional setting where transfer of information is particularly important. The doctor-patient interaction has received a lot of attention from a theoretical perspective (McGuire 2000) yet the impact of emotions in the two parties' decisions is not properly examined. Of course, our model can be applied to any setting where the information affects individuals' emotions as when an employer and employee discuss possible reductions in a company's personnel or when a teacher and a student consider the latter's performance in the final examination.

The originality of the model presented in this paper lies in two aspects. First, we relax the assumption of perfect agency that the models by Caplin and Leahy (2004) and Köszegi (2004) put forward. To do this, we introduce a linear utility function for the doctor and the notion of 'effort' that she needs to put in while supplying information to the patient. In contrast to the games by Caplin and Leahy (2004) and Köszegi (2004), ours is not a signalling game, i.e. the doctor receives no message regarding the patient's preferences. Secondly, we give to the patient an active role in decision making, and we allow for interdependent decisions under conditions of asymmetric information between the two parties. The doctor, being uncertain about the type of patient she diagnoses, decides how much information to pass on. The patient, receiving this information decides whether to accept it or not. Both these elements, as well as the other key aspects of our model are influenced by the medical literature in the area. This is reviewed in the following section.

Our analysis shows that when the supplier of information fails to understand the receiver's preferences the latter will disregard completely the recommendation. In the example of the doctor-patient relationship that we describe here, the implications of this become more apparent. Adherence to medication, generally defined as 'the extent to which patients take medications as prescribed by their health care providers' (Osterberg and Blaschke 2005), is of increasing importance in health care as it improves outcomes and controls health care costs. For example, a review of studies on antipsychotic treatment estimated that the national re-hospitalization costs related to non-adherence was on average $1.479 million in the USA in 2005 (Sun et al. 2007).

The rest of this paper is organized in the following way. Section II summarizes observable facts from the medical literature that lead to the conceptualization of our model. Particular emphasis is given to the supply of information during the consultation and how this affects communication and the final decisions. Section III presents our model which takes the form of a non-cooperative game between the doctor and the patient. Section IV discusses the main findings of our model, along with the policy recommendations and welfare implications. These are based on ways of improving adherence rates, analyzing the solution of the model, and on the effects of changing the values of the various parameters. Section V summarizes and concludes the discussion.

II. MOTIVATING FACTS

There is consistent evidence showing that the flow of information exchanged during the consultation is very critical for the formulation of diagnosis and the organization of treatment (Lambert and Loiselle 2007). Thus, effective communication is necessary to ensure not only that the doctor understands the patients' problems and concerns but also that appropriate information on diagnosis and treatment is accurately and effectively transferred to maximize the benefits from consultation (Weinmann 1997).

Information regarding patients' health affects their emotions and patients vary in their preferences regarding how much they want to know about their health (Miller and Mangan 1983). Not all patients want precise information or benefit from it. This is particularly the case with cancer and other life-threatening conditions, where supply of bad news is a rather sensitive issue. For example, a study by Siminoff and Fetting (1991) found that patients who did not accept their physician's treatment recommendations were told in more specific terms what the benefits of the treatment would be. The study suggested that provision of detailed information will not always provide desirable results and in fact may lead to different therapy decisions than the physicians might hope for, such as departure from her recommendations.

Doctors, on the other hand, through their communication style can positively influence these beliefs and therefore contribute to better adherence to recommendations (Bultman and Svarstad 2000). However, they are often unable to understand differences in patient preferences regarding information and participation during consultation (Elkin et al. 2007). They often fail to listen to patients and explore their views on their disease and medication. Moreover, the doctor, just as the patient, also experiences feelings during the consultation such as anxiety and anger which have been shown to decrease the overall satisfaction of both parties and also the patient's adherence to recommendations (Waitzkin 1984).

The transmission of information during the doctor-patient interaction has been shown in the literature to be related to the clinical setting (Waitzkin 1984). Busy clinical settings often imply that the doctor may be restricted in the time she can spend with every patient. She may therefore fail to provide information due to a heavy work load and time limitations.

Following the discussion above, four aspects of the doctor-patient relationship that affect supply of information and may impact on non-adherence are important for our analysis. First, information affects a patient's beliefs and these have an impact on the patient's decision regarding treatment. Secondly, patients vary in their preferences regarding information. Some patients want precise information, while others are better off when they do not receive much detail about their condition. Models based on the PEU theory take this into account. Thirdly, doctors do not appear to be consistently able to predict patient preferences. This uncertainty concerning the patient's type introduces an element of asymmetric information between the two parties which is captured in our model by presenting a game of complete but imperfect information. Finally, supply of information requires effort from the doctor's side which she wishes to reduce given time constraints and working load.

We now combine all these elements to develop our non-cooperative game theoretic model aiming to explore whether it may explain non-adherence to recommendations. We also wish to apply comparative statics to the optimal decisions and thus obtain policy recommendations.

III. THE MODEL

Background Information and Assumptions

The model takes the form of a game in an extensive form. It is a non-cooperative game between two players; the patient ('he') and the doctor ('she'). It is played in the present (Period 1) when decisions are made taking into account the expected state of health of the patient in the future (Period 2). The patient has symptoms of an illness and visits the doctor. He does not have precise information about his state of health and relies on the doctor to make the diagnosis. The doctor makes a diagnosis that, given the recommended treatment, the patient's state of health in Period 2 will be s_1 with probability p and s_2 with probability $1-p$, where $s_1 < s_2$. This is the best diagnosis the doctor can make. The medical recommendation may refer to medication taking, exercise uptake or diet suggestions.

Patients vary in their preferences regarding the amount of detailed information they want to receive and, following the work by Miller (1987), are distinguished between 'blunters' (B), i.e. information-averse, and 'monitors' (M), i.e. information-loving patients. The type of patient, in our model, is decided by Nature (N). This is a summary term which is used to denote all factors which determine the type of patient who visits the doctor.

In general, the doctor cannot tell with certainty whether the patient is a monitor or a blunter. Given the circumstances she can only make a guess. With probability q she believes that the patient is a monitor and with $1-q$ he is a blunter. Under this uncertainty the doctor decides whether to transfer (T) to the patient all the information, i.e. to tell him that he can be in state s_1 with probability p and in s_2 with $1-p$ or not to transfer all the details (NT). In the latter case she calculates $E[s] = p \cdot s_1 + (1-p) \cdot s_2$ and tells the patient that his predicted state of health is $E[s]$, if he follows the recommendations, without disclosing details about s_1 and s_2. In case the doctor plays *T,* the expected $E[s]$ can be calculated by the patient as well.

The patient, after the information received by the doctor, needs to decide whether to accept the recommendations and adhere (A) or not (NA). Non-adherence in our model implies two things. First, it means that if the patient does not follow the doctor's recommendations, there is a possible loss in his health denoted by l, which we assume to be a non-negative constant common for all types of patients, i.e. it is independent of patient's preference regarding information. Second, non-adherence implies that the patient decides to ignore the doctor's advice, even when all information is provided to him. I.e. he assumes that $E[s]$ is his state of health and acts accordingly. This is precisely the case of the second and sixth terminal nodes in Figure 2.

Consider the following example. A doctor sees a patient with a severe heart condition and makes a diagnosis. She cannot tell with certainty how many years the patient will live, yet she can say that if he follows her recommendations, that is goes on a diet, stops smoking and takes the medication as prescribed, in the worst case scenario his life expectancy will be 2 years with 40% probability or in best case 10 years with 60%. On average, his life expectancy is 6.8 years. The doctor can decide to reveal the whole picture to the patient (*T*) or simply tell him that life expectancy is 6.8 years (*NT*). If the patient of our example non-adheres (*NA*) he intentionally disregards the information that his life expectancy can be as low as 2 and as high as 10 and only accepts that his expected life expectancy will be 6.8. In other words in the PEU theory a monitor prefers early resolution of uncertainty, while the blunter does not.

A key concept in our model is that of effort which we assume the doctor needs to expend in order to supply the information. The term ε_1 denotes the effort of the doctor if the patient is a blunter and ε_2 her effort if the patient is a monitor. Both ε_1 and ε_2 are positive constants and are subtracted from the doctor's utility function every time the doctor decides to play T. It is assumed that $\varepsilon_1 < \varepsilon_2$. That is, more effort is needed to pass on information to a monitor, who is an information-seeking person, than to a blunter, who is information averse. This is a reasonable assumption based on the literature which points out that information-loving patients are not only more demanding (Miller 1995) but also more 'difficult' than information averse ones (Miksanek 2008).

In addition, a number of emotions are experienced by both parties during the consultation. Here, we denote by a the anger that is created if a monitor realizes that the doctor has not told him all the truth. It is assumed that a is a positive constant and it is subtracted both from the monitor's and the doctor's utility. We assume that $a > \varepsilon_2$, i.e. the anger created if the doctor does not pass on all the information is greater than the effort the doctor puts in to do so. This would make the doctor be more careful in expending the right amount of effort in making her recommendation.

We denote by w the worry that a monitor experiences, without expressing it to the doctor, if he decides to follow her advice although he has realized that she has not told him the truth. It is assumed that w is a positive constant and it is subtracted from the monitor's utility. Both anger and worry are used in our model to capture what Miller (1995) discusses, i.e. that monitors are not only more demanding in seeking information but they also require more emotional attention than blunters as they experience a number of emotions during the consultation. The constants ε_1, ε_2, a and w are expressed in (dis)utility terms.

Finally, by u_M and u_B we denote the utilities of a monitor and a blunter respectively, while u_D is the utility of the doctor. Their basic forms, before the relevant constants above are subtracted, are explained in detail below.

The utility functions used in our model have similarities to the ones developed by Köszegi (2003) but they are not identical. They are based on the PEU which is defined not only over physical outcomes but also over beliefs about future physical outcomes. The patient needs to decide in Period 1 whether to follow the doctor's advice according to what he believes his health will be in Period 2. His von Neumann-Morgenstern type utility function depends ultimately on his health state s, the action he decides to take, and is conditional upon his attitude to information.

We first consider the case of a blunter, i.e. an information-averse patient. Similar to a risk-averse individual, who comparing utility to expected utility does not take a fair gamble, an information-averse patient prefers to know what the expected state his health can be rather than knowing the probabilities with which he will be in worse or better state. Or as Köszegi (2003) puts it he "dislikes bad news more than he likes good news". Consequently, the utility function for the information-averse patient is (strictly) concave and differentiable (Figure 1 (a)).

Knowing his expected health $E[s]$ gives him greater utility, $u_B(E[s])$, than the utility he would get if he expects to be in state s_1 with probability p and in state s_2 with probability $1-p$, which reduces his utility to $E[u_B(s)]$. Using the example of the patient with the heart problem, if he is a blunter he prefers to know that his average life expectancy is 6.8 rather than knowing he may die in 2 years. The constant l can be either such that $u_B(E[s]-l) > E[u_B(s)]$ or $u_B(E[s]-l) < E[u_B(s)]$. The former case is presented in Figure 1(a). This means the patient may prefer to keep smoking although he knows that this has implications (l) for his health. This gives him greater utility than if he received the information and followed the recommendations. The reverse case can also be presented on a graph and can be interpreted.

For the information-loving monitor, the picture is reversed. He prefers to know the probabilities with which his state of health will be better or worse rather than knowing the expected state. His utility function is convex throughout and differentiable (Figure 1 (b)). Knowing the probabilities with which he could be in states s_1 and s_2 gives him a utility of $E[u_M(s)]$ while knowing the expected state of health reduces his utility to $u_M(E[s])$.

Of course, the patient will also take into account the possible loss in health, if he does not follow the doctor's recommendation, and the constants expressing his emotions if he is not happy with the consultation.

{Insert **Figure 1** here**}**

For the doctor's utility function we make two assumptions. First, her utility increases as the patient's health does, but she is information neutral to his prospects of health, i.e. her utility is linear, that is $u_D = c \cdot s + d$, where following a normalization $u'_D = du_D / ds = c = 1$. Linearity implies that $u_D(E[s]) = E[u_D(s)]$ and also that $u_D(E[s]) - u_D(E[s]-l) = c \cdot l = l$. Second, she takes into account the effort she needs to put in every time she transfers information, as well as the negative atmosphere, i.e. anger, a, that is created if she does not pass on the full information to a monitor.

The calculation of the payoffs of the doctor and the patient is done by taking into account their preferences about information, the strategies chosen by both players, the effort expended and the possible anger and worry caused. After the relevant constants are subtracted from the utility functions we obtain the payoffs which we assume are revealed by Nature. For example if the patient decides to non-adhere he will soon observe a deterioration (l) in his health. The revelation of payoffs by Nature takes place only at the end of a complete path, from the initial to a terminal node. This implies that the doctor cannot infer the identity of the patient by observing, for instance, the anger of a monitor who is not being given the information he wants.

Both the doctor and the patient consider the effect of their own actions, taking into account the choice of their opponent, with a view of maximizing their individual payoffs. Therefore, the game we present is non-cooperative.

We now consider the model in detail.

The Structure of Decisions in the Model

The extensive-form of the game is presented through the tree in Figure 2. Nature (N) moves first, at time 0, and selects the type of the patient. The doctor does not know the type of the patient she is dealing with. This is represented in the game tree by the information set I shown by the dotted closed curve which contains two nodes. When the doctor finds herself in I and wishes to play a pure strategy then it must be the same from both nodes. This is the significance of the information set I. The game described is of complete but imperfect information and perfect recall.

In order for the doctor to be able to take an action, and thus for the optimal paths to be calculated, she attaches a probability q that the patient is a monitor and a probability $1-q$ that he is a blunter. The value of q may imply that the doctor knows exactly the wheel that Nature spins in selecting the patient, i.e. q is the true proportion of monitors in the population of patients. On the other hand, q may also represent the beliefs of the doctor, perhaps on the basis of collected information through a number of previous consultations, that the patient chosen by Nature is of a particular type with a given probability.

A specific case of q is considered in detail. This is the case of $q = 1/2$, which implies that if there is really no reason to suppose that the patient is of either type one or the other type, a way forward is for the doctor to set $q = 1/2$.

Following the decisions of the doctor, the patient will act and decide whether to adhere or not to the recommendation.

{Insert **Figure 2** here**}**

As explained above, the doctor's pure strategies are $\{NT, T\}$. Each pure strategy is played from both nodes in information set I.

The payoffs of each player depend on the strategies chosen by both players and are given by the vectors at the terminal nodes, with the first element referring to Player 1, the doctor, and the second to Player 2, the patient.

<u>The Game Under Perfect Information.</u> First we consider briefly the circumstances when the doctor has full information concerning the type of patient. This covers for example the case where the patient is in a position to reveal his preferences to the doctor. Obviously, $q = 1$, with certainty, corresponds to the case where there is only one type of patient, i.e. a monitor, and $q = 0$, with certainty, when the patient is definitely a blunter. In other words, in both cases the doctor knows exactly the type of patient she is dealing with. Then the analysis is straightforward.[1]

We discuss the two cases separately. If the patient is known by the doctor to be a monitor (M) and she has given him the information he wants, i.e. she has played T, then he will play A

[1] For more details see Stavropoulou and Glycopantis (2008).

since $E[u_M(s)] > u_M(E[s]-l)$ as shown in Figure 1 (b). So, in this case the patient will adhere. However, if the doctor plays NT, i.e. she does not pass on all the information, and the player is a monitor, then he will get angry and will express his anger in his payoff. This reduces both the utility of the patient and the doctor by a. In addition to that, the constant w is used to express the patient's worry if he accepts the treatment while he knows that the doctor has not passed him all the information he wanted. This brings the patient's utility further down, in a way that it is assumed to imply: $u_M(E[s]-l)-a > u_M(E[s])-a-w$. In this case therefore, the patient will play NA, i.e. he will not adhere to the doctor's recommendations. Taking into account the optimal responses of the patient, the action which maximizes the payoff of the doctor is T, because $E[u_D(s)]-\varepsilon_2 > u_D(E[s]-l)-a$ because $a > \varepsilon_2$. Therefore, she decides to reveal all the information. The analysis justifies the conclusion that the optimal path is (T, A). The doctor has taken into account the patient's preferences and the latter has responded positively. We have also obtained the characterization of a subgame perfect equilibrium which is a Nash equilibrium from every node that the player might have to act.

Let us now consider the case when the patient is known to the doctor to be a blunter (B). If she plays NT, i.e. she does not give all the information, then the patient will decide to play A because $u_B(E[s]) > u_B(E[s]-l)$. On the other hand if the doctor plays T, then it depends on the relation between $u_B(E[s]-l)$ and $E[u_B(s)]$. The two possibilities are shown on Figure 1 (a). For relatively small l we have $u_B(E[s]-l) > E[u_B(s)]$, the patient prefers not to adhere and will play NA. For large l we have $u_B(E[s]-l) < E[u_B(s)]$. The patient is frightened that the possible loss in health is too big if he does not follow the doctor's recommendation and decides to play A, i.e. to adhere. In all circumstances, taking into account the optimal responses of the patient, the action which maximizes the payoff of the doctor is NT. Therefore she decides not to reveal all the information.

The analysis justifies the conclusion that the optimal path is (NT, A). The doctor has taken into account the patient's preferences and the latter has responded positively. We have also obtained the characterization of a subgame perfect equilibrium, in which if the doctor plays T the choice of the patient will depend on the value of l.

Hence we have obtained the following:

Summary Statement 1: Under perfect information, in the case of the monitor the optimal decisions are that the doctor plays T and the patient A. In the case of the blunter, irrespective of the relationship between $u_B(E[s]-l)$ and $E[u_B(s)]$, the optimal decisions are that the doctor plays NT and the patient A. We have also characterized the subgame perfect equilibria.

In both the case of a monitor and that of a blunter the patient adheres and this has significant implications which we consider in the discussion section.

The Game Under Imperfect Information. We now return to the general case when the doctor finds herself in information set I. As said above, the dotted closed curve shows that the doctor does not know exactly where she is in the information set I. She will attach probabilities, expressing her beliefs, q that the patient is a monitor and $1-q$ that the patient is a blunter.

Below, given $0 \le q \le 1$, we consider the optimal decisions of the patient and the doctor. We note that given the beliefs of the doctor, the optimal paths describe a Nash equilibrium, since nobody can improve his payoff given the strategies of the other. In more technical terms, the optimal decisions describe an assessment equilibrium (Binmore 2007), as it is defined not only in terms of what the players do, but also in terms of what they believe. The case of insufficient reason is given special attention as describing a possible situation when the doctor and the patient meet for the first time.

Case 1. First we conduct the analysis under the hypothesis that $u_B(E[s]-l) > E[u_B(s)]$. When the patient has to act he knows exactly his type, i.e. whether he is at point 2 or 2' etc., therefore if he is a blunter and he respond to T with NA and to NT with A. If he is a monitor he will respond to T with A and to NT with NA. He is aware of his payoffs and he can reach an optimal decision. Following the optimal decisions of the patient, the tree in Figure 2 folds up into the one in Figure 3. This shows the moves available for the doctor, along with the payoffs for every move for both the doctor and the patient.

{Insert **Figure 3** here**}**

If the doctor plays NT her payoff will be:

$$U_{NT} = q \cdot [u_D(E[s]-l)-a]+(1-q)\cdot u_D(E[s]) = u_D(E[s]) - q\cdot l - q\cdot a . \qquad (1)$$

If the doctor decides to play T her payoff will be:

$$U_T = q\cdot(E[u_D(s)]-\varepsilon_2)+(1-q)\cdot[u_D(E[s]-l)-\varepsilon_1] = q\cdot l - q\cdot\varepsilon_2 + u_D(E[s]) - l - \varepsilon_1 + q\cdot\varepsilon_1 . \qquad (2)$$

We now examine for which q, let us call it $q*$, the doctor is indifferent between playing T or NT. For this to hold, the payoffs of the two actions must be equal, i.e. $U_{NT} = U_T$. Employing (1) and (2) we require:

$$q\cdot[u_D(E[s]-l)-a]+(1-q)\cdot u_D(E[s]) = q\cdot(E[u_D(s)]-\varepsilon_2)+(1-q)\cdot[u_D(E[s]-l)-\varepsilon_1]. \qquad (3)$$

Or equivalently:

$$q\cdot l + q\cdot a = (1-q)\cdot(l+\varepsilon_1)+q\cdot\varepsilon_2 . \qquad (4)$$

This is the marginal condition that for indifference between the two actions the expected loss in utility from playing NT must equal that of T. This is an important marginal condition of the type that is encountered throughout economic theory.

The solution to the above equation, $q*$, is given below:

$$q* = (l+\varepsilon_1)/(l+\varepsilon_1+l+a-\varepsilon_2) = X/(X+Y) \qquad (5)$$

where: $X = l+\varepsilon_1 > 0$ and $Y = l+a-\varepsilon_2 > 0$.

We also conduct a comparative statics analysis by calculating the partial derivatives. We have $\partial q^* / \partial a < 0$ and $\partial q^* / \partial \varepsilon_2 > 0$. With respect to ε_1 we have $\partial q^* / \partial \varepsilon_1 = (l + a - \varepsilon_2)/(2l + \varepsilon_1 + a - \varepsilon_2)^2$ which is positive since $l + a - \varepsilon_2 > 0$. With respect to l we have $\partial q^* / \partial l = (a - \varepsilon_2 - \varepsilon_1)/(2 \cdot l + \varepsilon_1 + a - \varepsilon_2)^2$, which is an inconclusive result as the numerator can be positive, negative or zero. This is due to the fact that as the possible loss in health increases this affects the utility of both the monitor under action NT and the blunter under T. This loss in health is reflected in a decrease in the doctor’s payoff and therefore, it affects both U_T and U_{NT}. Both these functions decrease and the strength with which they do so depends on the belief of the doctor as to the type of the patient. The overall outcome is inconclusive.

The doctor’s decision whether to supply all the information or not depends on whether U_T is greater or less than U_{NT}, respectively. The two functions are shown graphically in Figures 4 (a) and 4 (b). For $q > q^*$ the doctor will be playing T while for $q < q^*$ she will be playing NT.

<Insert **Figure 4** here >

From the above we derive further comparative statics results. From equations (1) and (2) we obtain that as ε_1 and ε_2 go up, i.e. the required effort of the doctor to pass on information increases, she will be more willing to play NT. On the other hand as ε_1 and ε_2 decrease she will be more willing to play T. Furthermore, when a increases, i.e. the anger of the monitor goes up when the doctor does not pass on all the information to him, she will be more willing to play T. However, when a decreases the doctor will be more willing to play NT.

We have thus obtained the following:

Summary Statement 2: Case 1 was constructed under imperfect information, i.e. for $0 \le q \le 1$, and for a relatively small l. The optimal decision of the monitor will be to adhere if the doctor plays T and non-adhere is she plays NT. The optimal decision of the blunter is not to adhere if the doctor plays T and to adhere is she plays NT. The doctor taking into account the patient's optimal responses, will play T, i.e. she will transfer all the information, if $q > q^*$, and NT if $q < q^*$, where q^* implies $U_{NT} = U_T$. The latter relation implies that the marginal condition of equality between the expected loss of actions NT and T is satisfied. The value of q^* changes as the parameters a, ε_1 and ε_2 change.

We now want to examine what the doctor will do in the particular case when she attaches equal probability to the patient being a monitor or a blunter, i.e. $q = 1/2$.

The doctor is indifferent between playing T or NT when $q = q^* = 1/2$. Equivalently, we have:

$$X/(X+Y) = 1/2 \Leftrightarrow -\varepsilon_1 = -a + \varepsilon_2 \Leftrightarrow \varepsilon_1 + \varepsilon_2 = a . \qquad (6)$$

In order to interpret the above conclusions, we write the above condition (6) as:

$$(1/2)\cdot(\varepsilon_1 + \varepsilon_2) = (1/2)\cdot(0 + a) . \qquad (7)$$

The left-hand side of the above equation (7) is the average disutility of effort if the doctor plays T and the right-hand side is her average disutility if she plays NT. When this holds, the doctor is indifferent between U_{NT} and U_T and therefore she is indifferent on whether to play T or NT.

The doctor will play NT if $U_{NT} > U_T$ which, based on the above, is equivalent to $\varepsilon_1 + \varepsilon_2 > a$. This implies $q^* > 1/2$. Following the interpretation used above, this means that the doctor will not pass on all the information to the patient if the average disutility of effort of providing the information is greater than her average disutility if she does not. The patient will then play A, i.e. will adhere, if he is a blunter or NA, i.e. will not adhere, if he is a monitor. The optimal decisions describe an equilibrium.

When $U_{NT} < U_T$, that is equivalent to $\varepsilon_1 + \varepsilon_2 < a$. This implies $q^* < 1/2$. The doctor will pass on all the information to the patient if the average disutility of effort of doing so is lower than her average disutility if she does not. The patient will then play A, i.e. will adhere, if he is a monitor or NA, i.e. will not adhere, if he is a blunter. Again the optimal decisions describe an equilibrium.

For $q^* < 1/2$ and $q = 1/2$ the optimal paths are shown in Figure 2 through the black lines from the nodes in the information set to two terminal nodes. This of course holds under the assumption that $u_B(E[s]-l) > E[u_B(s)]$.

The above results mean that for $q = 1/2$ an equality between $\varepsilon_1 + \varepsilon_2$ and a will be replaced by an appropriate inequality as parameters change, and the doctor will no longer be indifferent between playing T or NT.

Hence we have obtained the following results:

Summary Statement 3: In the case of insufficient reason, i.e. for $q = 1/2$, the doctor taking into account the optimal responses of the patient, as described in Summary Statement 2, will be indifferent between playing NT and T if the marginal condition of equality between the expected loss of the two actions is satisfied. This now takes the form $(1/2)\cdot(\varepsilon_1 + \varepsilon_2) = (1/2)\cdot(0 + a)$, which means that the average disutility of effort if the doctor plays NT must equal that of playing T. A change in the parameters will imply that the doctor will opt for one of the actions.

Case 2. We now consider briefly the implications of the alternative hypothesis $u_B(E[s]-l) < E[u_B(s)]$. This holds for a big enough l. The first implication is that at node 2" in

Figure 2 the blunter will choose to adhere to the doctor's recommendation. As a result, in Figure 3 the payoffs on the branch NBT will be replaced by $E[u_D(s)]-\varepsilon_1$ and $E[u_B(s)]$ for the doctor and the patient respectively. This means that equations (2) to (5) will be adjusted accordingly. Equations (1) and (2) are now written in the following way:

$$U_{NT} = u_D(E[s]) - q \cdot a - q \cdot l \,. \tag{8}$$

$$U_T = u_D(E[s]) + q \cdot \varepsilon_1 - \varepsilon_1 - \varepsilon_2 \cdot q \,. \tag{9}$$

Hence for $U_{NT} = U_T$ we require:

$$q \cdot l + q \cdot a = (1-q) \cdot \varepsilon_1 + q \cdot \varepsilon_2 \,. \tag{10}$$

This is again the marginal condition that for indifference between the two actions the expected loss in utility from playing NT must equal that of T. This is an important marginal condition of the type that is encountered throughout economic theory.

The solution to equation (10) is given by:

$$q^* = \varepsilon_1 /(l + a + \varepsilon_1 - \varepsilon_2) \,. \tag{11}$$

In terms of comparative static results, straightforward calculations imply that: $\partial q^* / \partial l < 0$, $\partial q^* / \partial a < 0$, $\partial q^* / \partial \varepsilon_1 > 0$ and $\partial q^* / \partial \varepsilon_2 > 0$. In other words, as a and l increase q^* decreases while as ε_1 and ε_2 increase so does q^*.

For $q > q^*$ the doctor will be playing T while for $q < q^*$ she will be playing NT (Figure 5).

<Insert **Figure 5** here>

From the above we derive further comparative statics results. From equations (8) and (9) we obtain that as ε_1 and ε_2 go up, i.e. the required effort of the doctor to pass on information increases, she will be more willing to play NT. That is similar to the Case 1. On the other hand as ε_1 and ε_2 decrease she will be more willing to play T. Furthermore, when a increases, i.e. the anger of the monitor goes up when the doctor does not pass on all the information to him, she will be more willing to play T. However, when a decreases the doctor will be more willing to play NT. Similarly, when the loss of health due to non-adherence increases, i.e. l increases, the doctor will be willing to play T, which can be interpreted as a way of shocking the blunter.

Under the principle of insufficient reason, i.e. $q = 1/2$, straightforward calculations imply that the relations between $\varepsilon_1 + \varepsilon_2$ and a will be replaced by those between $\varepsilon_1 + \varepsilon_2$ and $a + l$. In particular relation (7) will take the form:

$$(1/2)\cdot(\varepsilon_1 + \varepsilon_2) = (1/2)\cdot(a + l). \tag{12}$$

Again the interpretation is similar to that of (7) in the case where $u_B(E[s] - l) > E[u_B(s)]$. The left-hand-side denotes the average disutility if the doctor plays T. The right-hand-side denotes the average disutility if the doctor plays NT.

The simplicity and the explicit form of both (7) and (12) relate to the linearity of the doctor's utility function. We note that w, expressing a monitor's worry that he is following a recommendation although he has not been told all details, does not enter into the marginal condition. This is so because w does not enter into the doctor's payoff.

With respect to comparative statics results the strength of l will be added to that of a. Apart from this change, the effect of a variation in the parameters on the decision of the doctor will be analogous to Case 1. In particular for $q^* = 1/2$ will now be achieved for a smaller value of a.

We have now obtained the following results:

Summary Statement 4: Case 2 was constructed under imperfect information and for a relatively large l. Again the optimal decision of the monitor will be to adhere if the doctor plays T and non-adhere if she plays NT. On the other hand, the blunter will adhere if the doctor plays NT but he will also adhere if she plays T. This is due to the fact that he will be frightened from the large value of the possible loss, l, if he does not adhere. Again the doctor takes into account the optimal responses of the patient. Both in the case of the general $0 \le q \le 1$ and that of insufficient reason, the marginal condition of equality between the expected loss of actions NT and T is now different because the expression for U_T does not contain l. Hence, the value of q^* which satisfies the marginal condition will be different. Of course changes in the value of the parameters away from the marginal condition will mean that the doctor will opt for one of the actions only.

All these comparative statics results provide useful insights for understanding the welfare implications that can be derived from the analysis. They will be discussed below.

IV. DISCUSSION, WELFARE IMPLICATIONS AND POLICY RECOMMENDATIONS

We consider now the significance of our model both in terms of theoretical contributions, policy recommendations and welfare implications.

From a theoretical perspective, to the best of our knowledge, this is the first attempt to develop a model that explains why an individual, may not adhere to the recommendations of an expert. This is the case where the information that the expert passes on affects the emotions of the individual who receives it. We relax the assumption of perfect agency, that previous papers have adopted, by allowing the doctor to have her own, linear utility function and introducing the notion of effort that she needs to expend when supplying information to the patient. Moreover, their decisions depend on different elements. The doctor's utility is independent of the particular information preference of the patient and effort is rather a general concept that is employed to demonstrate that she is not expected to maximize merely the patient's utility function. It has been used here as a proxy for a set of factors, and in future research their particular effect could be explored further.

Consideration of the effort that will be needed during the consultation impact on the doctor's decision and consequently on the patient's decision to adhere or not. The results show that the doctor will compare her expected disutility of putting in effort with the expected disutility of not doing so. The latter will include the anger of a monitor patient who realizes that he has not been told the truth. The patient will be more willing to accept the doctor's recommendation if she has successfully supplied the information he wants regarding his state of health.

Asymmetry of information played an important role in our model. Indeed, when the doctor had exact knowledge of the patient's type the analysis showed that the patient would receive the type of information he wanted and would adhere. When, on the other hand, the doctor failed to capture a patient's preferences he would not adhere.

The assumption of asymmetry of information is more appropriate in situations where the patient visits the doctor for the first time to get a diagnosis, and there is no prior information regarding the type of the patient. An interesting expansion of the model, and a better approximation of reality, would be to consider explicitly the case where the patient visits the doctor more than once. In this case, it might then be possible for the doctor to deduce the patient's type from the effort that she put in previously and his subsequent state of his health. This will have implications for the subsequent games played. It may partially explain why visits to the doctor over longer periods, may improve adherence among patients.

The model suggests that decisions depend also on the size of l, i.e. how significant the possible loss in health due to non-adherence is. For relatively large l, the doctor has more reason to supply the information and play T. In this case, interestingly enough, the blunter despite being information-averse will adhere to the recommendations. This may be perceived as the doctor successfully passing on the information in an attempt to "shock" the blunter, who then follows the recommendations.

Frank explains that Gilboa and Schmedler (1995) argue that "policies that reduce distortions in decision making would be viewed as welfare improving" (Frank 2007, p. 218). Our model supports this view. From a policy perspective, the model clearly supports tailored care as a way of improving adherence rates. Patients who were given the type of information they wanted were more likely to adhere to the recommendation of the doctor. Provision of all the information will not always give desirable results and in fact may lead to different therapy decisions from those that the physicians might hope for (Siminoff and Fetting, 1991). Indeed, literature on tailored care has shown that interventions which focus on the patient's individual needs increase satisfaction with care and improve adherence rates (Kreuter et al., 2000).

To enhance tailored care a number of interventions can be suggested, such as better doctor's training to increase her ability to detect different information preferences. In addition, administrative support may also be helpful. Various instruments have been validated and repeatedly used to identify 'monitoring' and 'bluntering' preferences. The Miller Behavioral Style Scale (MBSS) is one of the most well known and frequently used instruments developed by Miller (1987). Completing this scale enables the doctors, especially when seeing patients for the first time, to have information regarding the type of patient they are about to meet and therefore pass on the appropriate information.

An obvious suggestion to reduce conflict between the desire to improve the patient's health and the effort doctors need to put in would be to reward them for this effort. Yet, if financial incentives are given as a reward to doctor's effort, results will not be straightforward and may have unintended consequences. In particular, as shown in both Case 1 and 2, as ε_1 and ε_2 decrease due to the reward the doctor tends to play T, i.e. she will tend to pass on to the patient all the information. This would increase adherence rates among monitors, i.e. information loving patients but will have the opposite effect for blunters.

Our model also showed that the doctor's decision to put effort into the consultation depends also on a, i.e. the negative atmosphere created when a monitor realizes that she has not passed on all the information. The constant a can be perceived as the lack of trust developed during the consultation. If a decreases, i.e. an atmosphere of more trust is created, the model shows that the patient reaches the same decision. However the doctor could move from an indifference point to the possible $\varepsilon_1 + \varepsilon_2 > a$. In this case the doctor will play NT. In other words, for situations in which the consultation is characterized by trust, that is a small a, the doctor can put in less effort, i.e. spend less time with the patient and still achieve adherence. As the model shows this is to the benefit of the blunter.

V. CONCLUDING REMARKS

The investigation in our paper has focused on the doctor-patient relationship and the supply of emotional information that the consultation very often involves. We showed that this can lead to non-adherence to medical recommendations, a particularly significant problem for health care as it reduces health outcomes and increases expenditure. In our analysis we have attempted to consider the various factors which affect the patient's and the doctor's decisions and may explain why the patient departs from the doctor's recommendation. Of course, the model applies in general when information has to be passed on in an emotional setting. For example, a teacher gives advice to her stressed student regarding possible exam results, avoiding disappointing him if he is information-averse but at the same time encouraging him to adhere to a strict working schedule.

Our methodological contribution is that we relax the perfect agency assumption, which has dominated the literature, in order to capture reality which is that patients and doctors have different utility functions. We also, allow for asymmetry of information. Our game theoretic approach captures patients' differences in preferences for information about their health, and allows for interdependent decisions to be made. By so doing we provide an explanation of non-adherence. Yet, we show that even when conflict exists between the two parties it is possible to achieve better adherence rates and we identify the conditions under which this is the case. This is important from a policy perspective.

Having considered the welfare implications of our model we make a number of policy recommendations, including that of care tailored to the patient's information needs. Better medical training, as well as administrative support which identifies the type of patient can contribute towards tailored and more personalized care. We also show that financial rewards for the doctor's effort may benefit the information-loving patients but will not have the same effect on those who are information averse. Finally, we show that in situations where the potential health loss due to non-adherence is high, the doctor is better off passing on all the information even to information-averse patients, as this will "shock" them and lead them to adhere.

To conclude, our model was developed to capture the basic features of existing empirical evidence regarding the behavior of the two parties. It was built under specific but reasonable assumptions and offers an interdependent decisions analysis and a complete resolution of the game. It also employs a comparative statics analysis and gives economic interpretations. It draws upon the current new ideas in the literature of psychology and economics which have contributed greatly to our understanding of the doctor-patient interaction. Of course there is need for continual updating of both the empirical evidence and the theoretical investigation. The present paper adds to the cumulative theoretical and policy recommendations knowledge in the area.

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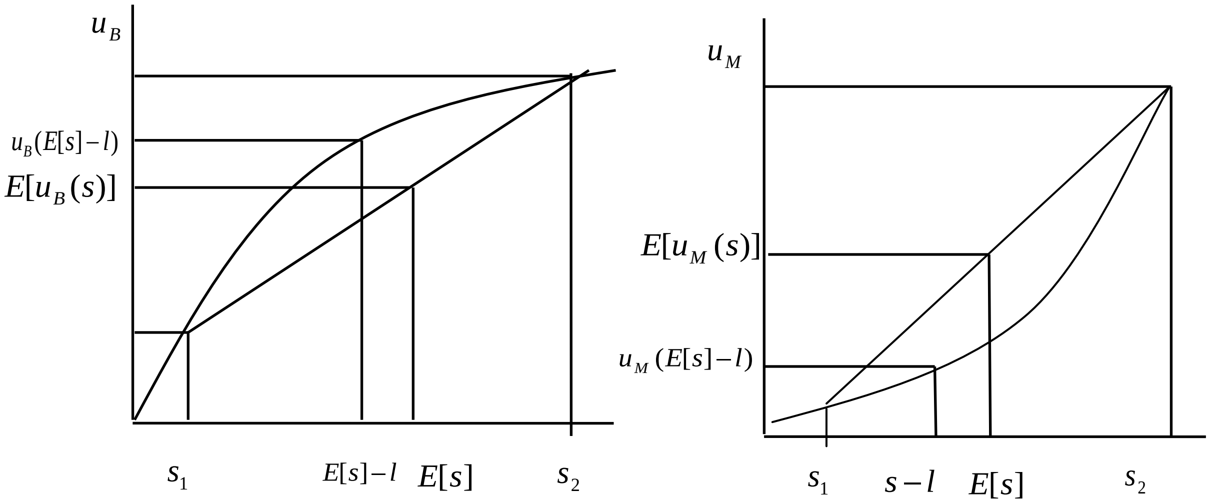
FIGURE 1**:**

Utility function for a blunter (a) and a monitor (b).



(a) (b)

FIGURE 2:

Extensive form of the game indicating the optimal paths if doctor plays T.

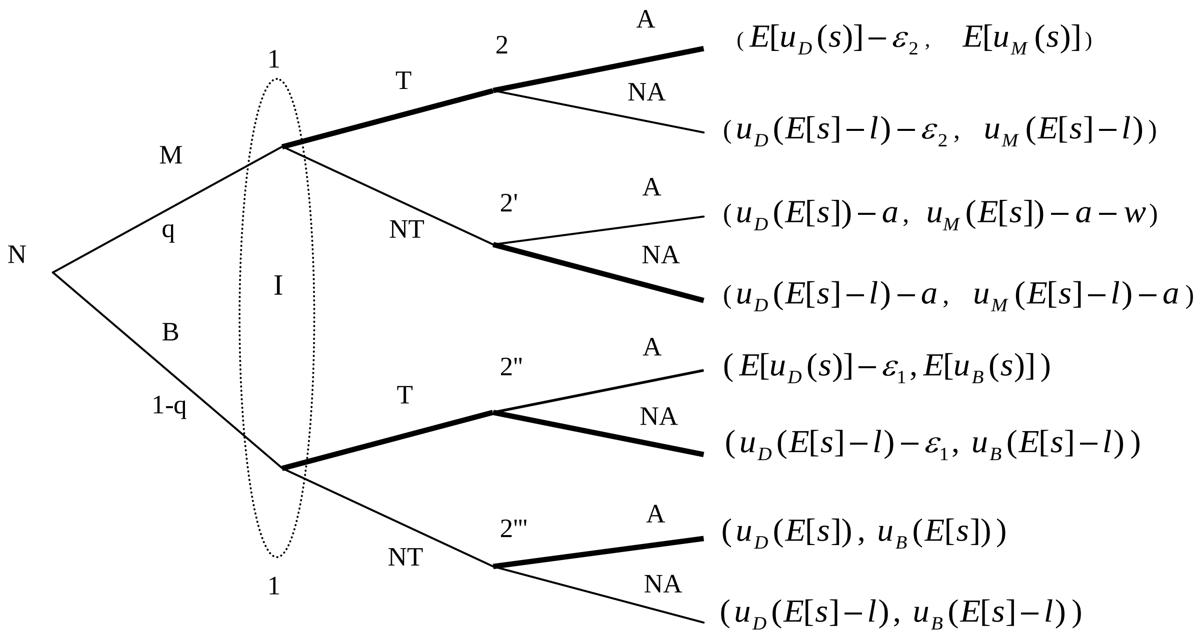


FIGURE 3:

Backward induction

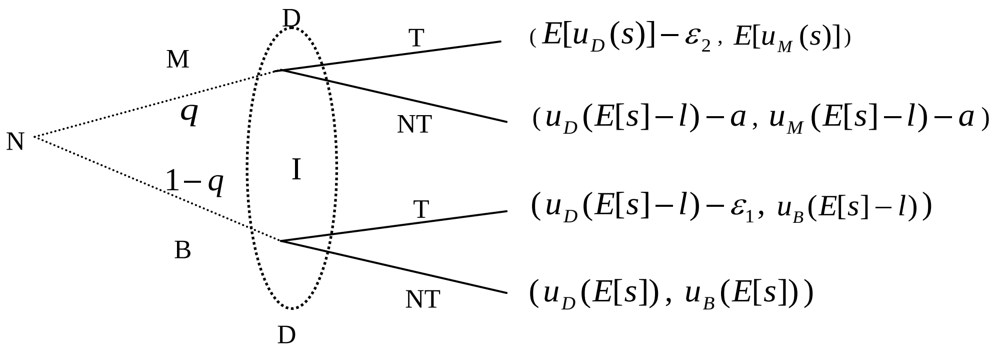


FIGURE 4 (a):

The utilities U_T and U_{NT} for $\varepsilon_2 > \varepsilon_1 + l$ (Case 1).

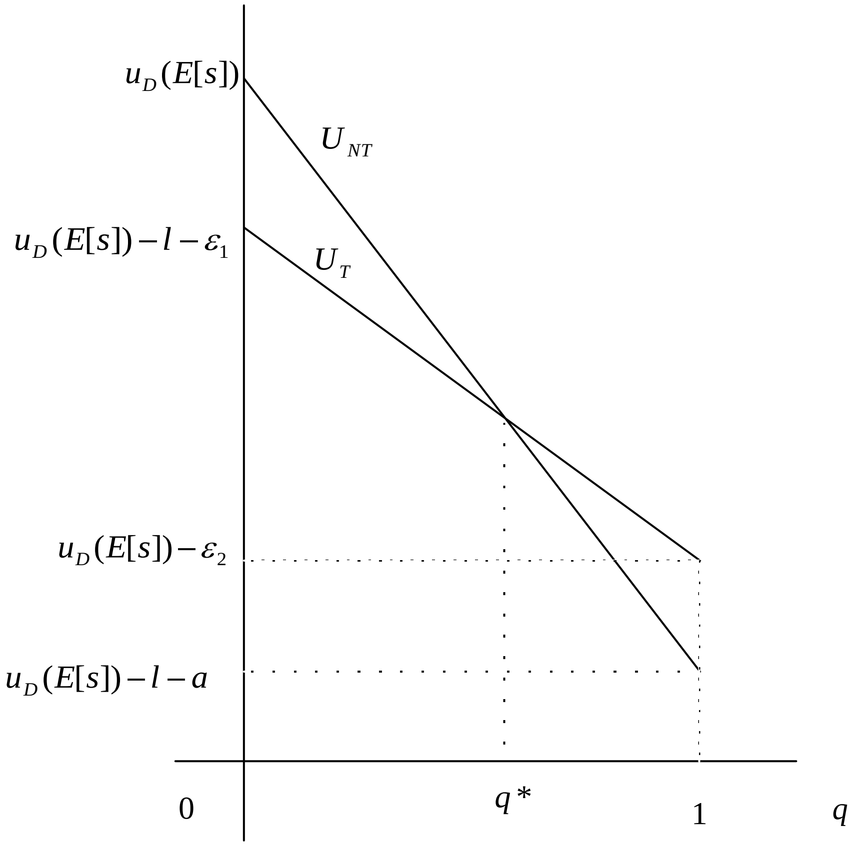


FIGURE 4 (b):

The utilities U_T and U_{NT} for $\varepsilon_2 < \varepsilon_1 + l$ (Case 1).

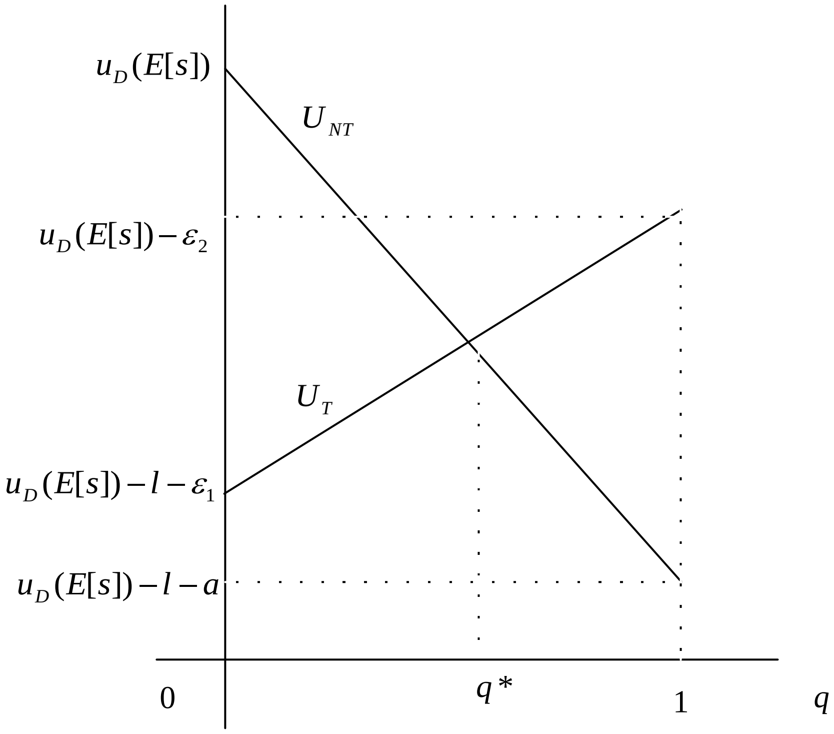


FIGURE 5:

The utilities U_T and U_{NT} for $\varepsilon_2 > \varepsilon_1$ (Case 2).